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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 31.

Rev. 1899

ALFALFA, OR LUCERN.

BY

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WASHINGTON:
GOVERNMENT PRINTING OFFICE.

1899.

LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
DIVISION OF AGROSTOLOGY,
Washington, D. C., January 21, 1899.

SIR: I have the honor to transmit herewith copy for a revised edition of Farmers' Bulletin No. 31, Alfalfa, or Lucern. This bulletin was prepared in accordance with instructions from your office by Mr. Jared G. Smith, assistant agrostologist, and submitted for publication in July, 1895. The demand for it still continues, and some changes and corrections have been found necessary to make it available for distribution at this time.

Very respectfully,

F. LAMSON-SCRIBNER,
Agrostologist.

Hon. JAMES WILSON,
Secretary of Agriculture.

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ALFALFA, OR LUCERN.

Medicago sativa L.

Alfalfa has been grown with more or less success in every State and Territory in the Union, from Maine to Washington, and from California to Florida. There is not a State from which the report has not gone out that alfalfa will, when properly treated, become one of the best fodder plants. It is the best hay and soiling crop in the West. In the South it has been widely recommended as a very valuable addition to the list of forage grasses and clovers. In the Middle and Eastern States it promises to become a rival of the better known and more widely grown red clover.

NAME.

The early Greeks and Romans called lucern medicai, or, in Latin, medica or herba medica, because it was brought from Media. The name lucern, by which this plant is known in Europe and in the eastern portions of the United States, is a corruption of the old Cataline name "nserdas," whence comes the common name "laouzerdo" used in the south of France. From this, by easy transition, the name luzerne or lucern has been derived. It has been supposed by some authors that the name was derived from Lucerne, one of the Swiss cantons; but the plant has been introduced into that portion of Switzerland only within comparatively recent times, so that it is highly improbable that the name was derived from this source. Other authors have thought that the name might have been derived from the Lueerne in Piedmont, but De Candolle in his Origin of Cultivated Plants inclines to the belief that the name comes from the Spanish or Provençal names before quoted. The name alfalfa, on the contrary, is of Arabic origin—alfafa or alfalfa. The Arabic name was at one time the more commonly used in Spain, and when the plant was carried into Mexico by the Spaniards, and later to the western coast of South America, the Arabic name went with it. In ordinary usage lucern is the name applied to the plant in the Eastern and Southern States, as well as in the European and nearly all other foreign countries in which the plant is cultivated.

HISTORY.

Alfalfa, or lucern (*Medicago sativa*), has been cultivated as a forage plant for more than twenty centuries. It is a native of the valleys of the central district of western Asia, having been found in an

apparently wild condition in the region to the south of the Caucasus, in several parts of Beloochistan and Afghanistan, and in Cashmere. It was introduced into Greece at the time of the Persian war, about 470 B. C. The Romans often cultivated it as forage for the horses of their armies. It was in especial favor with them as a forage crop during the first and second centuries, and its cultivation has been maintained in Italy down to the present time. From Italy it was introduced into Spain and the south of France. It was carried from Spain into Mexico at the time of the Spanish Invasion, and thence to the west coast of South America. It was brought from Chilo to California in 1854, and from there it rapidly spread over the arid regions

of the Pacific Coast and Rocky Mountains, where it is now cultivated almost to the exclusion of other forage plants.

Lucerne was introduced into the State of New York at least as early as 1820, or more than thirty years before it was brought to California; but it has never been so extensively cultivated there as on the Pacific Coast.

DESCRIPTION.

Alfalfa, or lucern, is an upright, branching, smooth perennial, 1 foot to 3 feet high. Its leaves are three-parted, each leaflet being broadest above the middle, narrowly oblong in outline and slightly toothed toward the apex. The purple, pea-like flowers, instead of being



FIG. I.—Alfalfa; *a*, *b*, seed pod; *c*, seed.

in a head, as in red clover, are in long, loose clusters, or racemes. These racemes are scattered all over the plant, instead of being borne, as in red clover, on the upper branches. The ripe pods are spirally twisted through two or three complete curves, and each pod contains several seeds. The seeds are kidney-shaped, yellowish brown, and average about one-twelfth of an inch long by half as thick. They are about one-half larger than red clover seed, and are of a bright egg-yellow, instead of a reddish or mustard yellow. The ends of the seeds are slightly compressed where they are crowded together in the pod.

VARIETIES.

Besides the cultivated form, there are two others which by some are considered as simply forms or varieties of alfalfa, while others regard them as distinct species. They are the intermediate lueern (*Medicago media*) and the yellow, or sand, lueern (*Medicago falcata*). Neither of them has much agricultural value, though the yellow lucern is sometimes recommended for planting on very light and sandy calcareous soils. It is more easily killed by excess of water, but is said to endure cold better than alfalfa. It is probably less valuable than many other species of clovers and forage plants. Alfalfa seed is sometimes adulterated with the seeds of one or the other of these less valuable forms. These plants, however, are so rarely cultivated in the United States that there is little danger of this method of adulteration being largely practiced here.

The western alfalfa grows taller than the eastern lueern, and is said to withstand drought and freezing better. This is probably because it has been so long subject to the peculiar soil and climatic conditions of the arid regions of Chile, California, and Colorado that it has become thoroughly acclimated. Alfalfa in the West very rarely kills out by winter freezing, although the temperature in certain regions in which it is largely grown is as low in winter as in the Eastern and New England States. In this latter section the plant frequently fails to go through the second season on account of the freezing of the roots.

There is also a variety known as Turkestan alfalfa, which has recently been introduced into cultivation in this country by the Agricultural Department. This variety grows on the high table-lands of central Asia and is especially adapted to the sudden changes of temperature which prevail there—intense heat in midday and very often frost at night, even in midsummer. It resembles the ordinary cultivated form of alfalfa, except that the leaves are shorter and sparsely clothed with short hairs. Its cultivation has been quite successful in the arid portions of the West.

HABITS OF GROWTH.

Alfalfa is a deep feeder. The taproots descend to great depths wherever the soil is loose and permeable, often averaging 10 or 12 feet. It has been recorded as sending its roots to the depth of 50 and 66 feet, and it is believed that under especially favorable circumstances they may go even deeper. “The young plant consists of a number of low branches springing from a simple basal stalk at the crown of the root. These branches ascend directly above ground and form a compact tuft. On the old plant, however, certain of the more robust stems elongate underground and become new branch-producing stocks. In this way the simple stock, or rhizome, becomes two or many headed.” When the stems are cut or grazed off, the stalk dies down to the very base, and new buds spring up on the upper part or crown of the root and

grow, forming new stems. This method of growth explains why so many farmers have reported that alfalfa is injured or destroyed by continuous close grazing. The stems of many other forage plants, when cut or broken, branch out above ground, forming lateral shoots that immediately grow up and take the place of the old stem. If alfalfa is closely grazed, and if every young stem is eaten off as rapidly as it appears, the vitality of the root will be impaired and the plants may die, because the new growth comes directly from the root itself, and not from the bases of the old stems. There is more danger of killing out the alfalfa fields when sheep are pastured on them than by the pasturing of cattle, horses, or hogs, as the latter do not graze the plants so closely as do sheep, except at times when there is insufficient forage.

SOILS AND CONDITIONS OF GROWTH.

Alfalfa will grow in favorable soil anywhere from about sea level to 7,000 feet elevation. The limit of altitude is attained in the foothills and mountain valleys of California and Colorado. Alfalfa does not seem to be influenced so much by altitude as by such conditions as the depth and warmth of the soil, the depth of the ground water below the surface, and the physical character of the subsoil. It grows best in a light and sandy rich loam underlaid by a loose and permeable subsoil. The best conditions for the growth of this plant seem to be attained in the arid regions of the West and Southwest, where there is a light rainfall, and the water supply can accordingly be artificially controlled. The plant grows best under irrigation. Good drainage is necessary, as the plants are quickly killed by excess of water in the soil or on the surface. Water must never be allowed to stand on a field of alfalfa more than forty-eight hours at a time, for, if the ground becomes saturated with water and is allowed to remain so for any considerable length of time, the plants will be drowned out and the roots will decay. Alfalfa feeds most heavily on lime, potash, magnesium, and phosphoric acid, and succeeds best where the soil is rich in these elements. Of these soil constituents, lime seems to be the most essential to rapid growth, and there will not be a large or paying crop on soils lacking this fertilizer. The prime condition for success is that the land be well drained. If the subsoil is heavy and stiff and impervious to water, alfalfa will not be a permanent success, no matter how well the surface soil has been prepared. Under these conditions there can be no certainty of the plant living beyond a year or two.

PREPARATION OF THE SOIL.

A clean piece of ground should be selected, and it should be thoroughly plowed and subsoiled. If the farmer has no subsoiling plow, the best substitute is two turning plows, the one following in the furrow made by the other. The best results from this crop are obtained after

the second year, because alfalfa does not reach maturity until the third or fourth season. Hence the field selected should be one that can be kept in alfalfa for a number of years. The first cost of a deep and thorough preparation of the soil may seem large, but it must be remembered that the farmer expects to take two or more cuttings off the land each year for from three to thirty years. The primary expense of a thorough preparation is, in a sense, thus spread over a series of years. Deep plowing pays, because there will be a greater yield from the land than in the case of the too common shallow cultivation. After plowing, the field must be harrowed and rolled several times, or until the seed bed is perfectly smooth and mellow.

SOWING THE SEED.

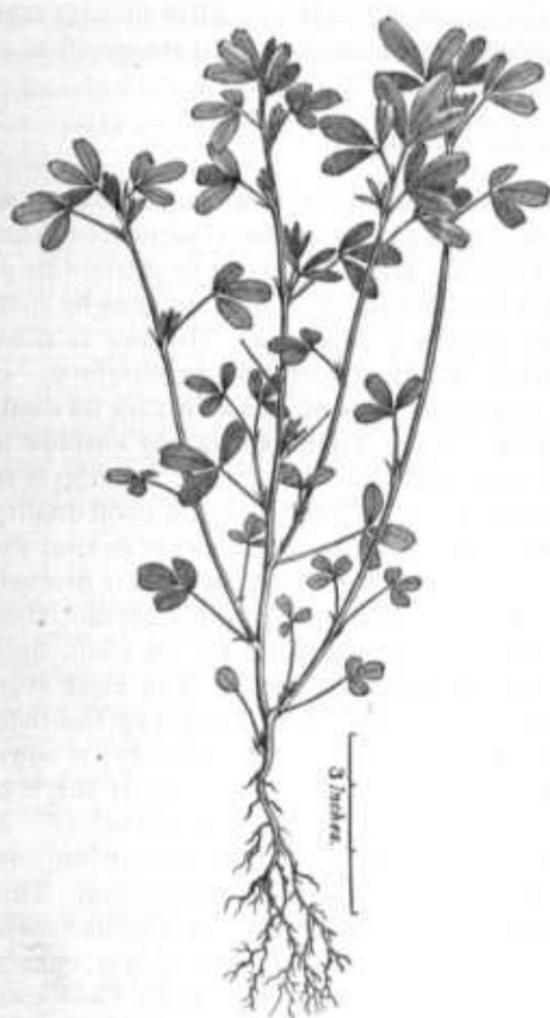
In the East and Northeast.—Alfalfa should be sown in the spring, as soon as the ground is warm and there is no further danger from hard frost. This is usually from about the middle of April to the middle of May. Young alfalfa plants are tender, and liable to be injured by cold. The seed may be sown either broadcast or drilled: Drilling is more economical of seed, and a better stand can usually be obtained. If sown broadcast, from 20 to 25 pounds of seed per acre may be used; if drilled, from 15 to 20 pounds. When a permanent hay meadow is desired, the larger amount of seed is the best; but when the crop is to be raised for seed, a smaller amount will suffice. To get a good quality of hay, the plants should be grown close enough together so that the stems will be small and not woody; but when a crop of seed is desired, they should be grown so far apart that, while covering the ground, they will put forth the greatest number of flower clusters. A clean field will require less seed than one that is very weedy. The most even stand is to be had by drilling the seed and then harrowing the field lightly across the drill rows. Cover the seed very lightly; if sown broadcast, a light harrow or brush will be sufficient; or, if there is rain immediately after sowing, no harrowing will be necessary. A better stand will be obtained if the land is rolled after sowing. In western New York the practice is to roll without harrowing. This presses the seed into the loose soil, and covers it to a sufficient depth. On light, sandy loams sow without any nurse crop. On clayey, eloddy soils, however, a light crop of wheat, oats, or barley is by some considered beneficial. This practice is also to be recommended when the field is liable to be very weedy; but it is really a waste of seed to sow alfalfa on foul land. The young alfalfa plants are more tender than young red clover, and are easily choked out by weeds, or by the nurse crop if the latter is too thick. A good and sufficient stand can not be counted on if the field is weedy, or if the seed is sown, like that of clover and timothy, with some small grain.

Some farmers cut for hay the first season. This depends entirely upon the rapidity of growth during the first summer. If the field is

weedy the weeds must be mowed two or three times and raked off the field. This must be done as often as the weeds grow up and threaten to choke out the alfalfa. If the field is very weedy it should be mowed early enough in the summer to keep the weeds from seeding. If this is done the alfalfa will soon take possession of the ground, and there will be little trouble from weeds or grass until after the third year. If a good stand is secured and the field is not weedy a small crop of hay may be secured the first season.

As a result of frequent cutting during the first season the plants will form a good root system and consequently make a better growth. The crop should not be cut too late in the autumn of the first year. The young plants will stand the rigors of cold of winter much better if they have been allowed to put out at least five leaves. In the preparation of a field for alfalfa the farmer must keep in mind the fact that alfalfa will yield better the second year than the first, and better the third year than the second; hence the advantage of enabling the crop to pass through the first winter in good condition.

In the South.—Experiment and practice have proved that the best results may be obtained from autumn sowing. In the Southern States more



depends upon the condition of the land than upon the alfalfa itself. Farmers who have been successful with this hay crop agree, in the main, that the best stand and best yield follow an autumn sowing. The Southern farmer must fight continuously against the many weedy grasses that spring up in his fields and that will choke out the young cultivated plants if allowed to gain the upper hand. If an attempt is made to establish a field of alfalfa by sowing the seed broadcast in

FIG. 2.—Alfalfa seedling, 6 weeks old.

spring, crab grass and foxtail are on hand to choke out the seedlings before they can get fairly started, and it is only in exceptionally favorable years that a good stand can be obtained in this way. September and February are the two months which have been found best for the sowing of alfalfa. The seed should be drilled at the rate of 20 to 25 pounds of seed per acre. The stand must be thick enough to enable the crop to hold its own against the weeds and weedy grasses which would otherwise take possession of the field.

As soon as the alfalfa is from 12 to 16 inches high the first crop can be mowed, and from that time it can be cut as often as it grows high enough. It is very important that the plants get a good footing and develop good root systems the first season. Alfalfa, when fully established, yields as much as 6, 8, 10, 12, and sometimes 16 tons of dry hay per acre per annum. The richer and cleaner the land, and the more thoroughly the soil has been prepared before sowing the seed, the larger will be the net profit from each acre.

Alfalfa in the South should follow some hoed crop, either cotton or corn, that has been kept free from weeds. In sections where the cotton root rot is prevalent it is not advisable to plant alfalfa in fields which are infected with this disease, for it is probable that the root rot of alfalfa is identical with that of cotton, and if the seed is sown upon land thus infected the crop will surely be lost. This forage plant responds promptly to intensive cultivation. Yet it is not advisable to apply fresh stable manure when preparing the ground. Such manure is always full of weed and grass seeds that have not been digested, and which are often in better condition to grow than seed scattered naturally in the field.

To fertilize the alfalfa field with barnyard manure is to deliberately sow a lot of injurious weed seeds. If the manure has been thoroughly rotted under shelter it will do, but not so well as though it had been applied to the previous crop, to be mixed and distributed through the soil before the ground was plowed for alfalfa. A dressing of commercial fertilizers, compost, or cotton-seed meal will increase the yield of hay and green forage. Barnyard manure may be applied in the second autumn and in each year afterwards, because there will then be less danger of the alfalfa being choked out by weeds. It is better to apply this dressing in autumn or early winter than in the spring, on account of the weeds. The average life of alfalfa in the South has not been definitely determined. The crop, however, will last just as long as the field can be kept clean. With good care the yield ought to be a ton per acre at each cutting, and four to eight cuttings each year.

In the eastern Rocky Mountain region and the middle North and Northwest.—Alfalfa is usually drilled or sown broadcast in spring as soon as the ground is warm, and when danger of hard frost is past. It is best to sow without a nurse crop. Where the land is under ditch, the field

should be irrigated before seeding, and never after seeding until the young plants are at least six weeks old. The first six weeks or two months in the life of the plant is the critical period of its growth. It is at this time very susceptible to any sudden changes of temperature or to any excess of water in the soil. If the land be irrigated directly after it has been plowed and harrowed, the soil becomes a reservoir of water necessary for the growth of the young plants, and no further irrigation will be required until the alfalfa is well established and the plants are less susceptible to cold. The seed should be covered very lightly to the depth of not exceeding an inch. A light harrow or brush will be sufficient. Drilling is more economical, and a better stand is usually obtained. If the farmer has a press drill, it would be better to use that; but care must be taken not to cover the seed too deep. If the seed is sown broadcast just before a rain, no harrowing or brushing will be necessary. In most of this Western region where alfalfa is extensively grown rains can not be counted on. In many localities the average yearly rainfall is very light, and this plan of irrigating the plowed field before the seed is in the ground is the best that has been tried.

The field may be mowed several times during the first season. To sow a field broadcast or to drill with a machine, from 20 to 25 or even 30 pounds of seed per acre may be necessary to insure a good stand. A better quality of hay will be got from an acre on which 30 pounds of seed are used than from one on which only half that amount has been sown. Alfalfa stems become hard and woody if the plants are too far apart, and the hay from such a field is coarse and unpalatable. There will be more waste in feeding to cattle or horses than if the stems are thinner and softer, as they surely will be if more seed is sown and there is a thicker stand. If the land is under ditch, water may be turned on the field once or twice during the first summer, or oftener if needed.

Land on which alfalfa is to succeed must be well drained here as in the East. It is a mistaken idea that alfalfa fields must be kept continuously water soaked. The plant can not and will not make its best development with wet feet. The soil must be deep, rich, and mellow, and the ground water not less than 6 or 8 feet below the surface. The soil in which it most delights is dry and well drained, and if, in addition to these qualities, the lay of the field is such that water can be turned on once or twice during the hot, dry summer, the very best conditions for the growth of alfalfa will be attained.

In preparing the field great care must be taken to have the surface smooth and mellow. If it is intended to irrigate, the land must be thoroughly leveled, and this leveling process will be much facilitated if the field is irrigated before the seed is planted. The high and low places will thus show themselves, and they can be scraped down or

filled up. It will pay to have the land perfectly smooth; more ground can be irrigated by one man in a day, and the water can be put to more economical use. Deep plowing is necessary to obtain the best results. Alfalfa will grow, and has often been reported as growing, on land the surface of which had been just lightly scratched; but the yield from such a field is never as heavy as when the ground has been thoroughly and deeply stirred for the reception of the seed. If the ground is clayey or heavy, and has any tendency to form a crust after being wet, the field should be harrowed as soon as the alfalfa is 3 or 4 inches high, so that this crust will be broken up. Such a harrowing, if done after the plants are fairly well started, will not injure the stand. If the alfalfa is irrigated two or three times the first season, to enable the young plants to make a good growth and form large roots, there is not much danger that it will winterkill. However, the field must not be irrigated too late in the season, when the ground is cold. More water is needed the first year than afterwards. Alfalfa is sometimes grown without irrigation. In such cases the success of the crop depends very largely on the thoroughness with which the ground has been prepared for the crop. Sandy soils require a larger quantity of water, but less frequent applications, than stiffer, clayey ones. If sown as soon as the ground becomes warm, the plants will rapidly develop deep roots, and when once well rooted they will stand more dry weather than any other forage plant.

In California and the Southwest.—Pulverize the soil to the depth of from 12 to 20 inches—the deeper the better. Twenty-five pounds of seed is about the average amount to sow per acre. Many farmers report fair results from a less amount, say 12 to 15 pounds per acre. The seed can be drilled in rows or cultivated or sown broadcast. The time of seeding varies much in practice, being any time from August to the middle of December or from February to April. Those who practice spring sowing usually sow with oats or wheat as a nurse crop. If this method is followed, one or two crops of hay can be cut the first season, after the grain crop has been taken off.

It is often better to sow without a nurse crop and get a good stand than to get a crop of wheat or oat hay or a small crop of grain and have a poor stand of alfalfa, resulting from so many of the plants being choked out. There is some little advantage, however, in this system, in that the rank growth of weeds is prevented; but the accompanying small grain is liable to be just as injurious as a rank growth of useless weeds would be. If a nurse crop is used, the alfalfa should be sown after the grain, and should be covered to the depth of not more than 1 inch with a light harrow or brush. Still better results will follow if the seed is rolled in after the oats or wheat have been sown. All kinds of grasses, clovers, and small grain grow better, and a better stand is always secured, if the soil is pressed down around the seed, and this can best be done with a roller. Alfalfa does not often winterkill unless it is cut too late in the season.

In some parts of California small birds are quite a pest at seeding time, and it is necessary to use more seed per acre than would otherwise be required.

Alfalfa grows better on land requiring irrigation than on naturally moist soils, simply because the latter do not, as a rule, have good drainage.

ALFALFA HAY.

There is no better hay plant than alfalfa in regions where it will grow. The making of hay requires considerable skill on account of the nature of the plant. If the hay is put into stacks or into barns before the stems are cured, it is liable to heat and mold, and if it is allowed to lie on the ground too long before stacking, the leaves get dry and brittle, and will drop off, and a large share of the most valuable part of the forage will be lost. To make the best hay, the field should be cut just when the first flowers commence to appear. If allowed to go until in full bloom, or until after the plants have finished flowering, the stems become hard and woody, and are unfit to be eaten by stock. To make good hay, cut alfalfa in the forenoon. Let it lie in the swath until the leaves are thoroughly wilted, but not dry and brittle; then rake in windrows and leave it a while, and remove it from the windrows directly to the stack or to the barns. The best machine for this purpose is a stacker, or some machine constructed on the principle of the old-fashioned "go-devil." It is better to stack in the field than to carry it a long distance to a barn, for alfalfa hay should be handled as little as possible. Every time it is forked over some of the leaves will be lost, and the leaves are the most palatable and nutritious part of the hay.

The art of making good alfalfa hay is to be acquired by practice rather than by following directions, as the quality depends upon putting it in stack when it is just sufficiently cured to keep without heating, and is yet green enough to hold the leaves. This happy mean can be acquired only as the result of practice. In the Eastern States the general practice is to cure in windrows, and then put in cocks 5 or 6 feet high and as small as will stand. If the cocks are too large, they must be opened out in a day or two, so that the hay in the middle will have a chance to dry. The cocks must be small enough to allow the air to get at every part of the hay. If the weather is hot and dry, the alfalfa will soon be thoroughly cured, and there will be no danger of its molding or heating. The curing process may be materially hastened if a tedder is used before the hay is raked, especially if the growth is a very rank one. The value of the hay will depend upon its being well cured before the leaves have commenced to drop off. An alfalfa stack will not turn water as readily as red clover or timothy. A hard, soaking rain will often decrease the value of the hay one-half, so that at an average price of \$10 per ton the loss will amount to \$5 per ton in feeding value. Where the land is under irrigation, the field should be flooded immediately after the first cutting and again after each subsequent cutting during the season, unless there have been rains.

The number of cuttings will vary from two or three in New York or Pennsylvania to seven or eight, and sometimes more, in California and the States bordering on the Gulf of Mexico. When grown on the most suitable soils, namely, those which are rich and well drained, and which abound in lime, potash, phosphoric acid, and magnesium, and with the stimulus of heat and moisture, alfalfa yields, with ordinary good care and cultivation, from one to two tons of rich nutritious hay every four to six weeks. It, however, deteriorates rapidly after the third year, unless taken care of. But, as already shown, with proper care the limit of profitable production need not be set at five or twenty, or even fifty years. There is in the State of Sonora, in Mexico, a field which is known to have been kept in alfalfa continuously for over sixty years, and it is said to be in as good condition to-day as it ever was.

WEEDS.

Alfalfa is often run out by weeds after the third or fourth year. This can easily be prevented. There is no excuse for such a proceeding, other than shiftless farming. Alfalfa is a very strong grower, and will hold its own if given but half a chance. If given a whole chance, there is no forage plant that will beat it. If there is a poor stand in places in the field, these should be reseeded as soon as they are noticed. Every spring the field should be gone over with a heavy harrow to loosen up the surface of the ground and kill out the weeds. With this small amount of cultivation, and an occasional dressing of composted stable manure or commercial fertilizer, an alfalfa field may be cut continuously for many years.

CUTTING FOR SEED.

When alfalfa is grown for seed, the second crop is the one usually saved. The yield from this is heavier, and, what is of more importance, the crop ripens uniformly. The first crop does not often seed well, probably because the insects which aid in the fertilization of the flowers are not present in sufficient numbers in May or early June, when the flowers first open. Cut for seed when the pods are dark brown. Rake at once into heaps and allow it to cure there; then place in the stack, and thresh directly from the stack. Stacks of alfalfa, whether cut for hay or seed, will not turn rain, and there should be a cap of some kind put over each stack. If the hay gets wet it will heat and mold, and there will be considerable loss. In Colorado the first crop is considered the best for seed, especially if it has not been irrigated. The plants are smaller and coarser than later in the season, and more thickly set with flowers than the ranker midsummer growth.

Considerable success has been had in Kansas, Nebraska, and Colorado in the cutting of seed alfalfa with a twine binder and threshing directly from the field or from the stack. A higher yield is claimed for this method, because the alfalfa is more easily handled and does not shell so readily as when it is cured in heaps or windrows. It is claimed

that there is a sufficient increase in the amount of seed saved to more than pay the additional cost of the binding twine, besides the saving in time and labor and the greater ease in handling the crop. The yield of seed varies greatly from year to year, according to natural conditions. The average is probably from 5 to 9 or 10 bushels per acre. Larger yields are sometimes reported. There are 60 pounds to a bushel of alfalfa seed. The price ranges in different parts of the country from 5 or 6 to 16 cents per pound. Alfalfa can be thrashed with any of the ordinary machines which have been provided with a set of screens of small mesh, such as are used for hulling clover. Seed intended for sale must be recleaned and run through a fanning mill before it is placed on the market. Higher prices are always to be got for clean seed. The alfalfa straw which is left after thrashing is worth less than half as much as the hay for feed.

FEEDING VALUE.

Alfalfa hay that has been properly cured is worth as much, weight for weight, as any other, and is eaten by all kinds of farm animals. It must be remembered, however, that it is not in itself a complete ration. It is very rich in protein; that is, in the albuminoids and similar nitrogenous compounds which, when fed to cattle, are transformed into blood, muscle, tendon, and bone. On the other hand, it is deficient in fat and the carbohydrates. To make alfalfa a complete ration, therefore, we must add something which contains large amounts of the latter substances. Fat and the carbohydrates must be fed at the same time as the protein, or the excess of the latter will not be digested by the animal. In order to get the best and most profitable results from feeding alfalfa, or any other forage plant that is rich in nitrogenous compounds, some of the coarser forage plants, such as corn fodder or silage, wheat or oat straw, millet, sorghum, or root crops, must be added to the ration. These are all poor in protein and rich in carbohydrates and fat, while alfalfa is rich in protein and poor in the sugars, starch, fat, and cellulose necessary to make the best feeding ration. It has been determined by experiment that a mixture of one ton of alfalfa hay and three tons of green corn fodder or silage will furnish food for one milch cow of 1,000 pounds weight for 136 days.

Alfalfa hay is a substitute for such substances as wheat bran and cotton-seed meal, usually purchased by the farmer to utilize the excess of carbohydrates furnished by his corn fodder or timothy hay, and since it can be grown on the farm there is a great saving in the actual cost of producing beef, pork, and mutton. Alfalfa hay can be fed profitably to all kinds of farm stock. It is especially valuable for young and growing cattle and horses, and for sheep. It may be fed to working horses with the addition of a small grain ration, and they will keep in good condition upon it. If fed in combination with prairie hay, wheat straw, silage or corn fodder, it makes a very nutritious forage,

and there is no better grass or clover with which to prepare stock cattle for fattening. Alfalfa-fed beef and mutton fattened up with corn command top prices in the markets. The farmer who wishes to save every bit of the valuable food substances which are in his corn and his alfalfa will feed the two together, so that what the one lacks will be supplied by the other. In this way beef, pork, and mutton can be grown for the market quickly and at the lowest possible cost.

SOILING VS. PASTURING.

Alfalfa is one of the very best soiling crops. It may be fed in this way to better advantage than if the stock are pastured on the field. Cattle and sheep can not be safely pastured on alfalfa, particularly when it is young and tender, or after there has been a heavy dew or rain. They are always liable to bloat if fed with green or wet alfalfa. Horses and hogs are not affected in this way. There are losses of sheep and cattle from tympanitis, hoven, or bloat, as it is called, every year, and, though a herd may go through an entire season without loss, it is never perfectly safe to pasture stock on alfalfa. By a proper arrangement of the feeding pens and corrals alongside or near the field, the method of soiling—that is, mowing the alfalfa and feeding it in a partially wilted condition—is a cheap and perfectly safe one. The additional cost and labor of cutting the crop and hauling it to the feeding pens will be less than the loss that will be sustained if several head of stock die or bloat during the season. Young horses will make a very rapid growth if pastured on alfalfa, especially if a small daily ration of oats is given. One of the disadvantages of depasturing alfalfa is that the soil soon becomes trampled and hard, and for this reason the roots are not able to make a sufficiently strong growth, and the field is sure to deteriorate.

ALFALFA FOR HOGS.

One acre of alfalfa will furnish forage for from ten to twenty hogs per season. There is no cheaper or better way of producing pork than to allow growing pigs to run in a field of alfalfa. At a conservative estimate, 10 pigs per acre will gain 100 pounds each during the season from May to September, and 1,000 pounds of pork can not be produced so cheaply on any other feed. The pigs will come out of the field in autumn in capital condition to fatten with corn or small grain. The alfalfa in a hog pasture should be moved once or twice during the summer or whenever it begins to get hard and woody. This will provide plenty of young and tender herbage, which is more nutritious, weight for weight, than forage from the older plants, and if the swine are provided with this food in its most nutritious condition, their growth will be most rapid. They need to be provided with an abundance of fresh or running water in the pastures.

ALFALFA IN THE ORCHARD.

Do not plant alfalfa in an orchard. The roots go down deeper than those of the fruit trees, and the latter will make no growth, if, indeed, they are not killed by the alfalfa. There is no better way of preparing the soil for an orchard than to sow this forage plant, but before setting out the trees the ground must be thoroughly rid of it, or there will be trouble. The alfalfa roots penetrate the subsoil in every direction, often to considerable depths. Mineral fertilizers are brought up from depths to which roots of other than leguminous plants do not penetrate. The soil is opened up and becomes more porous, and the dead and decaying roots furnish organic food in the best form for the rapid growth of the roots of trees. The alfalfa roots also collect nitrogen from the air, so that when the field is turned under large quantities of this element, so necessary to the life and growth of plants, are left stored for the use of the next succeeding crop.

FEEDING AND FERTILIZING VALUE OF ALFALFA.

One hundred pounds of freshly cut alfalfa contain at time of flowering 28.2 pounds of dry matter,* and of this the amount digestible is 3.89 pounds of crude protein, 11.2 pounds of carbohydrates, and 0.41 pound of fat, so that the nutritive ratio is 1 to 3.1. One hundred pounds of alfalfa hay contain the following digestible constituents: 10.58 pounds of crude protein, 37.33 pounds of carbohydrates, and 1.38 pounds of fat, with a nutritive ratio of 1 to 3.8. At the Massachusetts Experiment Station 1,000 pounds of the dry substance of alfalfa hay was found to contain 81.1 pounds of ash, 16.5 pounds crude fat, 760.2 pounds carbohydrates, and 142.2 pounds crude protein. Alfalfa hay is much richer than clover hay, containing for every 100 pounds 54.5 pounds of digestible substances, of which about 11 pounds are crude protein. The relation of the crude protein of alfalfa hay to that of red clover is as 11 to 7.

The fertilizing constituents in 1,000 pounds of dry matter are 22.75 pounds of nitrogen, 5.61 pounds of phosphoric acid, and 16.53 pounds of potash. In Colorado 1,000 pounds of alfalfa hay were found to contain 22 pounds of nitrogen, 4.14 pounds of phosphoric acid, 25.48 pounds of potash, and 20 pounds of lime, and during one year three crops amounting to 3.8 tons per acre contained 167 pounds of nitrogen, 31 pounds of phosphoric acid, 194 pounds of potash, and 152 pounds of lime. In Kentucky the analyses of freshly cut alfalfa showed 4.22 per cent of crude protein, 0.81 per cent of crude fat, 10.9 per cent of carbohydrates, and 2.14 per cent of ash. Thus it will be seen that the composition varies somewhat in different portions of the country. These differences in composition may result from such causes as differences in development or variation in the amount of available plant food in the soil.

* Appendix to Yearbook of the Department of Agriculture for 1896.

ALFALFA AS A SOIL RENOVATOR.

Alfalfa belongs to that class of plants which are known as nitrogen collectors. The legumes, to which family alfalfa and all the clovers and their relatives belong, are able to draw nitrogen directly from the air. The roots of the plant, if examined, will be found to be covered with a great many small swellings or tubercles, and if sections of these tubercles are examined under a high-power microscope the tissues will be found to contain great numbers of bacteria. It is through the action of these minute organisms that the plant is enabled to take nitrogen directly from the air. Other families of plants, for instance the true grasses, which do not have these tubercles on the roots, are unable to take up any nitrogen, except such as may be in soluble form in the soil. Hence, alfalfa and its relatives are the best plants that can be grown by the farmer, for they provide large quantities of this most valuable and expensive fertilizing element for the use of succeeding crops.

By raising alfalfa the farmer not only provides an excellent quality, as well as a large quantity, of forage for his domestic stock, but he is at the same time enriching his fields, and doing it with a fertilizer which if purchased in the market would cost a great deal of money. When this crop is plowed under, or is fed to stock and the manure returned to the ground, it supplies a large quantity of nitrogen, which is especially valuable for small grains, grasses, and root crops, and which the latter are unable to acquire from the air for themselves.

The percentage of nitrogenous compounds found in the plant varies considerably, the maximum being in the early stages of its growth and the minimum about the time the seed commences to ripen. Hence, hay cut early, especially before the plant begins to bloom, is more nutritious, though much smaller in quantity, than that cut after the plant has begun to bloom.



FIG. 3.—Alfalfa, 3 years old.

Below are given the analyses of alfalfa hay grown at the Colorado station in 1888, made at four different periods in the growth of the plant:

	Cut June 4; beginning to bud; 77.65 per cent of water.	Cut June 20; full bloom; 69.71 per cent of water.	Cut July 13; bloom half turned; 60.89 per cent of water.	Cut Sept. 11; fully ripened seed; 49.30 per cent of water.
Water	8.11	9.37	9.50	8.56
Ash	11.62	11.68	11.90	8.43
Fat	3.61	3.34	3.85	3.02
Crude protein	18.19	15.22	12.87	11.67
Crude fiber	12.88	14.65	18.01	20.23
Nitrogen-free extract	45.59	45.74	43.78	47.18
	100	100	100	99.99

This shows that there is a constant decrease of crude protein and a constant increase of crude fiber from the time the buds first form until the seed is ripe and all growth has ceased. The crude protein is the most valuable part of the forage and the crude fiber the least. It is very easy to see why hay cut before flowering is better than that cut when in full bloom, if in the meantime it loses nearly 3 per cent of its valuable and commercially expensive albuminoids and gains 2 per cent by weight of indigestible fiber. Hay made from alfalfa cut about the time the first blossoms appear is sufficiently superior in quality to hay cut when the plant is in full bloom, or has begun to ripen its seed, to more than make up for the difference in bulk and weight. Analyses of alfalfa have been made at experiment stations and agricultural colleges in all parts of the country, and the chemical composition is found to vary according to the time at which the sample is cut. No two samples cut from different fields, or from different parts of the same field where the soils are different, or where the preparation of the ground has not been the same, will have exactly the same chemical composition, though the ratio of one constituent to another may be fairly constant.

DESTROYING ALFALFA.

To rid land of alfalfa is sometimes difficult. As the result of poor cultivation, of the attacks of fungus diseases or insects, the yield per acre may cease to be profitable. The best method is to plow the field in midsummer, turning the roots up to the hot sun. Then when the leaves begin to show above the sod cross plow. These two plowings will ordinarily be enough. Another method which is used in the West and Southwest, where irrigation is practiced, is to flood the fields and let the water stand for several days. Alfalfa is soon killed by excess of water in the soil. If the water is allowed to stand on the field two days in midsummer, when it gets pretty hot during the day, every root will be killed, and when the water has been drained off the land will be ready to be plowed and prepared for some other crop. A catch crop should be put in at once, so as not to allow the land to remain bare, and to prevent the leaching out of the most valuable fertilizing elements.

ENEMIES OF ALFALFA.

Weeds.—Mention has already been made of crab grass and foxtail. The worst weed which growers of alfalfa will have to conquer, and the one which causes the greatest damage, is dodder or loye viue. This weed, or at least the species which does the greatest damage, is an importation from Europe. It was brought to this country in flax and alfalfa seed, and has spread throughout all sections of the United States where alfalfa is grown. Dodder belongs to the morning-glory family, but, unlike the common weedy morning glories of the fields, it is parasitic. The stems are leafless, and look like orange or reddish-yellow threads. When the seed of the dodder germinates, the young plant is able to grow for a short time upon the supply of food which has been laid up for it in the seed, but unless its stem can come in contact with that of some plant upon which it can feed it will die. As soon as the young dodder plant touches a leaf, stem, or stalk of the alfalfa it twines around it and becomes closely fastened to the stalk by means of numerous suckers, which enter the tissues of the host plant. These suckers draw out from the alfalfa the soluble food materials, such as the sugars and oils.

The dodder grows very rapidly, forming tangled masses with its yellow stems, and the alfalfa soon becomes completely choked out. The only practicable remedy after this pest has become established is to mow the alfalfa in early summer, before the dodder begins to bloom, and to burn it where it lies. This will completely kill the dodder without injuring the alfalfa. Dodder can not be kept down by mowing, because it is usually attached to the alfalfa stalks just above the surface of the ground. The flowers of the dodder are produced very low down, and even if the upper portions of the parasite were cut off, they would ripen seed. Sheep are said to clean out dodder from the field. The best method of fighting dodder is the preventive one; that is, sowing nothing but pure seed. The seed of this parasite is only about one twenty-fifth of an inch long, or not over half as large as the alfalfa; so that if the seed is properly screened the minute dodder seed may be easily separated from the alfalfa.

Root rot.—In Texas and the Southern States alfalfa is attacked by a root rot which is believed to be identical with the root rot of cotton. A field which becomes infected with this disease had better be plowed under. The rot spreads in widening circles from the point of infection at a rate of from 50 to 60 feet per season, and if it is very bad it sometimes kills out an entire field in one season. A very free use of salt is said to kill out the disease, which is usually worst in dry seasons. Probably the best remedy is to plant for a number of years those crops which are not affected by this root rot, until the ground becomes entirely free from the spores of the fungus which causes the disease.

There is another disease which has caused considerable damage in

Texas, New Mexico, and Colorado. It is not very well understood, and is at present under investigation by this Department. It seems to follow the irrigation ditches, and is very probably caused by excessive flooding of the fields. In its effects it somewhat resembles the damping off of young plants in the greenhouse. The crown of the root rots, and the plant dies. The remedy which at onee suggests itself is to provide thorough drainage for the fields and to irrigate less frequently.

Spot disease.—In many portions of the Eastern and Southern States the fields become infected with a leaf-spot which sometimes causes considerable damage, and renders both the hay and forage of inferior quality. The best remedy for this disease is said to be frequent cutting. Whenever a field of alfalfa commences to get yellow, either all over or in spots, it should be cut, for the yellow color is a sure sign of disease.

Animal pests.—In the region west of the Missouri alfalfa fields are often infested with gophers and striped ground squirrels. These eat both stems and roots, and cause great damage. The best way to get rid of these pests is to drown them out, or, if the land can not be irrigated, to poison them by dropping phosphorized grain in their burrows.

SUMMARY.

Alfalfa seed weighs 60 pounds to the bushel.

For a hay crop sow 15 to 25 pounds of seed per acre.

For a crop of seed sow 14 to 18 pounds per acre.

Sow clean seed.

North of the latitude of Washington, D. C., sow alfalfa in the spring, as soon as the ground is warm—from the middle of April to the middle of May. Sow in drills or broadcast.

In the South and Southwest and in California sow alfalfa in spring or autumn. Sow in drills.

Do not cover the seed too deep.

Alfalfa grows best on a deep, sandy loam, underlaid by a loose and permeable subsoil. It will not grow if there is an excess of water in the soil. The land must be well drained.

Alfalfa is a deep feeder. Plow the land thoroughly; the deeper the better.

Alfalfa thrives best in soils containing lime, potash, and magnesium. It does not grow well in soils containing an excess of iron, or where lime is wholly absent.

Cut for hay when the first flowers appear. If cut after full bloom, the hay will be woody and less nutritious.

Cut for seed when the middle clusters of seed pods are dark brown.

To make alfalfa hay, cut in the forenoon and let it wilt; then rake into windrows. It should be cured in windrows and cocks, and stacked or put in barns with as little handling as possible. Great care is required in order to get it in stack before the leaves become too dry.

and brittle. The leaves are the most palatable and nutritious part of the hay.

Cover the stacks with caps. This will prevent loss by molding when it rains.

In the arid regions, where irrigation is practiced, put water on the field before sowing the seed, and immediately after cutting each crop of hay.

It is not safe to pasture either cattle or sheep on alfalfa, as they are liable to bloat when it is fed green. Feed them the hay, or practice soiling.

There is no better or cheaper way of raising hogs than to pasture them on alfalfa. One acre will furnish pasturage for from ten to twenty hogs during the season.

Horses can be pastured on alfalfa. There is no better hay for work animals, or for young, growing stock.

Alfalfa hay is not a complete ration. The best results are got by feeding it with corn fodder, ensilage, wheat or oat straw, or roots. Alfalfa contains large amounts of protein, which goes to form blood, bone, and muscle. It is deficient in the carbohydrates, namely, starch, fats, and cellulose or fiber. These must be added to the ration or a part of the protein will be wasted.

To rid a field of alfalfa plow in midsummer, turning up the roots to the hot sun. Or, if the field can be irrigated, let the water stand on it two or three days in midsummer. This will rot the roots, and after the water has been drained off the field can be plowed.

Do not let water stand on a field more than forty-eight hours.

Alfalfa hay, properly cured, has about the same value as red-clover hay. The yield is much greater. It can be cut from three or four to seven or eight times in a season, and yields from a ton to a ton and a half or more at a cutting.

Six to 10 bushels of seed is the usual yield per acre.

Keep the weeds mowed the first season, or they will choke out the young alfalfa.

Sow alone, without any nurse crop. The latter is often just as harmful as the weeds.

Screen alfalfa seed before sowing, to separate the dodder and other weed seeds. Dodder or love vine is the worst enemy of alfalfa. Prevention is better than cure.

FARMERS' BULLETINS.

These bulletins are sent free of charge to any address upon application to the Secretary of Agriculture, Washington, D. C. Only the following are available for distribution:

- No. 15. Some Destructive Potato Diseases: What They Are and How to Prevent Them. Pp. 8.
- No. 10. Leguminous Plants for Green Manuring and for Feeding. Pp. 24.
- No. 18. Forage Plants for the South. Pp. 30.
- No. 19. Important Insecticides: Directions for Their Preparation and Use. Pp. 20.
- No. 21. Barnyard Manure. Pp. 32.
- No. 22. Feeding Farm Animals. Pp. 32.
- No. 23. Foods: Nutritive Value and Cost. Pp. 32.
- No. 24. Hog Cholera and Swine Plague. Pp. 16.
- No. 25. Peanuts: Culture and Uses. Pp. 24.
- No. 26. Sweet Potatoes: Culture and Uses. Pp. 30.
- No. 27. Flax for Seed and Fiber. Pp. 16.
- No. 28. Weeds; and How to Kill Them. Pp. 30.
- No. 29. Souring of Milk, and Other Changes in Milk Products. Pp. 23.
- No. 30. Grape Diseases on the Pacific Coast. Pp. 16.
- No. 31. Alfalfa, or Lucern. Pp. 23.
- No. 32. Silos and Silage. Pp. 31.
- No. 33. Peach Growing for Market. Pp. 24.
- No. 34. Meats: Composition and Cooking. Pp. 20.
- No. 35. Potato Culture. Pp. 23.
- No. 36. Cotton Seed and Its Products. Pp. 16.
- No. 37. Kafir Corn: Characteristics, Culture, and Uses. Pp. 12.
- No. 38. Spraying for Fruit Diseases. Pp. 12.
- No. 39. Onion Culture. Pp. 31.
- No. 40. Farm Drainage. Pp. 24.
- No. 41. Fowls: Care and Feeding. Pp. 24.
- No. 42. Facts About Milk. Pp. 29.
- No. 43. Sewage Disposal on the Farm. Pp. 22.
- No. 44. Commercial Fertilizers. Pp. 24.
- No. 45. Some Insects Injurious to Stored Grain. Pp. 32.
- No. 46. Irrigation in Humid Climates. Pp. 27.
- No. 47. Insects Affecting the Cotton Plant. Pp. 32.
- No. 48. The Manuring of Cotton. Pp. 16.
- No. 49. Sheep Feeding. Pp. 24.
- No. 50. Sorghum as a Forage Crop. Pp. 24.
- No. 51. Standard Varieties of Chickens. Pp. 48.
- No. 52. The Sugar Beet. Pp. 48.
- No. 53. How to Grow Mushrooms. Pp. 20.
- No. 54. Some Common Birds in Their Relation to Agriculture. Pp. 40.
- No. 55. The Dairy Herd: Its Formation and Management. Pp. 24.
- No. 56. Experiment Station Work—I. Pp. 30.
- No. 57. Butter Making on the Farm. Pp. 15.
- No. 58. The Soy Bean as a Forage Crop. Pp. 24.
- No. 59. Bee Keeping. Pp. 32.
- No. 60. Methods of Curing Tobacco. Pp. 16.
- No. 61. Asparagus Culture. Pp. 40.
- No. 62. Marketing Farm Products. Pp. 28.
- No. 63. Care of Milk on the Farm. Pp. 40.
- No. 64. Ducks and Geese. Pp. 48.
- No. 65. Experiment Station Work—II. Pp. 32.
- No. 66. Meadows and Pastures. Pp. 24.
- No. 67. Forestry for Farmers. Pp. 48.
- No. 68. The Black Rot of the Cabbage. Pp. 22.
- No. 69. Experiment Station Work—III. Pp. 32.
- No. 70. The Principal Insect Enemies of the Grape. Pp. 24.
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- No. 72. Cattle Ranges of the Southwest. Pp. 32.
- No. 73. Experiment Station Work—IV. Pp. 32.
- No. 74. Milk as Food. Pp. 30.
- No. 75. The Grain Smuts. Pp. 20.
- No. 76. Tomato Growing. Pp. 30.
- No. 77. The Liming of Soils. Pp. 19.
- No. 78. Experiment Station Work—V. Pp. 32.
- No. 79. Experiment Station Work—VI. Pp. 28.
- No. 80. The Peach Twig-borer—an Important Enemy of Stone Fruits. Pp. 16.
- No. 81. Corn Culture in the South. Pp. 24.
- No. 82. The Culture of Tobacco. Pp. 28.
- No. 83. Tobacco Soils. Pp. 23.
- No. 84. Experiment Station Work—VII. Pp. 32.
- No. 85. Flesh as Food. Pp. 30.
- No. 86. Thirty Poisonous Plants. Pp. 32.
- No. 87. Experiment Station Work—VIII. Pp. 32.
- No. 88. Alkali Lands. Pp. 23.
- No. 89. Cowpeas. (In press.)

